## What is claimed is:

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1
              A method for updating coefficients in a decision
2
    feedback equalizer with an ISI canceller for canceling ISI
3
    from a plurality of first signals received from a channel,
 4
    the method comprising:
         decoding a first symbol comprising a set of the first
5
 6
               signals to generate a decoded symbol, wherein the
7
               first symbol has (k+1) chips, and k is natural
8
               number;
9
         obtaining a vector of error values computed as
10
               difference between the decoded symbol, and the
11
               first symbol;
         generating a temp matrix according to the decoded
12
13
               symbol and the vector of the error values;
14
         averaging the values of the elements in every diagonal
15
               line of the temp matrix to generate a Toeplitz
16
               Matrix; and
17
         updating the coefficients by the Toeplitz Matrix.
1
         2.
              The
                    method
                                 claimed
                                           in
                                               claim
                                                      1
                            as
2
    comprises:
 3
         updating coefficients according to a least mean square
 4
               algorithm:
         H(m+1) = H(m) + \mu T \{conj(E(m)) \cdot C(m+1)\};
 5
 6
         H(m) is coefficients at a symbol time m;
 7
         H(m+1) is coefficients at a symbol time (m+1);
 8
         i is a predetermined gain;
 9
         T is the Toeplitz Matrix;
10
         E(m) is the vector of error values; and
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- 11 C(m+1) is the decoded symbol at the symbol time (m+1).
  - 1 3. The method as claimed in claim 1, wherein, in the

- 3 (k+1), the  $h_{(i)}...h_{(2k+1)}$  are equal to 0.
- 1 4. A method for updating coefficients in a decision
- 2 feedback equalizer with an ISI canceller for canceling ISI
- 3 from a plurality of first signals received from a channel,
- 4 the method comprising:
- 5 decoding a first symbol comprising a set of the first
- signals to generate a decoded symbol, wherein the
- 7 first symbol has (k+1) chips, and k is natural
- 8 number;
- 9 obtaining a vector of error values computed as the
- 10 difference between the decoded symbol, and the
- first symbol;
- generating a temp Matrix T(m) according to the decoded
- 13 symbol and the vector of the error values,
- 14 wherein T(m) =

$$\begin{bmatrix} E^{\bullet}(n-k) \cdot C(n-k) & E^{\bullet}(n-k) \cdot C(n-(k-1)) & \cdots & \cdots & E^{\bullet}(n-k) \cdot C(n) \\ E^{\bullet}(n-(k-1)) \cdot C(n-k) & E^{\bullet}(n-(k-1)) \cdot C(n-(k-1)) & \cdots & \cdots & E^{\bullet}(n-(k-1)) \cdot C(n) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ E^{\bullet}(n-1) \cdot C(n-k)) & E^{\bullet}(n-1) \cdot C(n-(k-1)) & \cdots & \cdots & E^{\bullet}(n-1) \cdot C(n) \\ E^{\bullet}(n) \cdot C(n-k) & E^{\bullet}(n) \cdot C(n-(k-1)) & \cdots & \cdots & E^{\bullet}(n) \cdot C(n) \end{bmatrix}'$$

- where m is the symbol time of the first symbol,
- the chip times of the first symbol are from (n-k)

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to n, n and m are natural numbers and n=(k+1)m;
18
19
                         E(n) is a vector of error values at the chip time
20
                         n; and C(n) is the chip of the decoded symbol at
21
                         the chip time n;
22
                averaging the values of the elements in every diagonal
23
                          line of the temp matrix to generate a Toeplitz
                         24
                           \begin{bmatrix} (\sum_{i=0}^k E(n-i) \cdot C(n-i))'(k+l) & (\sum_{i=0}^{k-l} E(n-(i+l)) \cdot C(n-i))k & \cdots & E'(n-k) \cdot C(n) \\ (\sum_{i=0}^{k-l} E(n-i) \cdot C(n-(i+l)))k & (\sum_{i=0}^k E'(n-i) \cdot C(n-i))'(k+l) & \cdots & (\sum_{i=0}^{k-(k-l)} E'(n-(i+k-l)) \cdot C(n-i))'2 \\ \vdots & \vdots & \vdots & \vdots \\ (\sum_{i=0}^{k-(k-l)} E'(n-i) \cdot C(n-(i+k-l)))'2 & (\sum_{i=0}^{k-(k-l)} E'(n-i) \cdot C(n-(i+k-2)))'3 & \cdots & (\sum_{i=0}^{k-l} E'(n-(i+l)) \cdot C(n-i))k \\ E'(n) \cdot C(n-k) & (\sum_{i=0}^{k-(k-l)} E'(n-i) \cdot C(n-(i+k-l)))'2 & \cdots & (\sum_{i=0}^{k-l} E'(n-i) \cdot C(n-i))'(k+l) \end{bmatrix} 
25
26
                         where H(m) is the Toeplitz Matrix at the symbol
27
                          time m.
 1
                5.
                                  method as
                         The
                                                        claimed in
                                                                                 claim 4
                                                                                                    further
 2
       comprises:
 3
                updating coefficients according to a least mean square
 4
                         algorithm:
 5
                H(m+1) = H(m) + \mu T \{conj(E(m)) \cdot C(m+1)\};
 6
                H(m) is coefficients at a symbol time m;
 7
                H(m+1) is coefficients at a symbol time (m+1);
 8
                ì is a predetermined gain;
                T is the Toeplitz Matrix;
 9
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## Client's ref. :VIT03-0097 Our ref: 0608 9902 usf/ellon/steve

10 E(m) is the vector of error values; and 11 C(m+1) is the decoded symbol at the symbol time (m+1). 1 The method as claimed in claim 4, wherein, in the Toeplitz Matrix  $\begin{bmatrix} h_{(k+1)} & h_{(k+2)} & \cdots & \cdots & h_{(2k+1)} \\ h_k & h_{(k+1)} & \cdots & \cdots & h_{2k} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ h_2 & h_3 & \cdots & \cdots & h_{(k+2)} \\ h_1 & h_2 & \cdots & \cdots & h_{(k+1)} \end{bmatrix} \text{, for any } (2K+1) \geq i > 0$ 2 3 (k+1), the  $h_{(i)}...h_{(2k+1)}$  are equal to 0. 1 7. A decision feedback equalizer, comprising: 2 an ICI canceller for canceling ICI from a signal 3 received from a channel and outputting a first signal without ICI; and 4 5 an ISI canceller, comprising: a symbol decoder for decoding a first symbol 6 7 comprising a set of the first signals to 8 generate a decoded symbol; and 9 a symbol-base feedback filter with a plurality 10 coefficients for transforming the decoded 11 symbol by a Toeplitz Matrix  $\mathbf{H}(m)$  to cancel ISI from the present decoded symbol, and 12 13 generating an output signal; wherein the first symbol has (k+1) chips, the 14 15 Toeplitz Matrix is a (k+1)\*(k+1) matrix, m 16 is the symbol time of the first symbol, the 17 chip times of the first symbol are from (n-18 k) to n, n, k and m are natural numbers and 19 n = (k+1)m;

1

2

claim

7,

wherein

20  $\underbrace{\sum_{i=0}^{k}}_{i=0}^{k} E'(n-i) \cdot C(n-i) / (k+1) \qquad (\sum_{i=0}^{k-1}}_{i=0}^{k} E'(n-(i+1)) \cdot C(n-i) / (k+1) \qquad \cdots \qquad E'(n-k) \cdot C(n) \\ (\sum_{i=0}^{k-1}}_{i=0}^{k} E'(n-i) \cdot C(n-(i+1)) / (k+1) \qquad \cdots \qquad (\sum_{i=0}^{k-(k-1)}}_{i=0}^{k} E'(n-(i+k-1)) \cdot C(n-i) / (k+1) \qquad \cdots \qquad (\sum_{i=0}^{k-(k-1)}}_{i=0}^{k} E'(n-(i+k-1)) \cdot C(n-i) / (k+1) \\ (\sum_{i=0}^{k-(k-1)}}_{i=0}^{k} E'(n-i) \cdot C(n-(i+k-2)) / (k+1) ) / (\sum_{i=0}^{k-(k-1)}}_{i=0}^{k} E'(n-i) \cdot C(n-i) / (k+1)$ 21 22 where E(n) is a vector of error values computed as 23 the difference between the chip of 24 decoded symbol at the chip time n, and the 25 chip input to the symbol decoder at the chip 26 27 time n, and C(n) is the chip of the decoded 28 symbol at the chip time n. 1 8. The decision feedback equalizer as claimed 2 claim 7, wherein the coefficients are updated according to a least mean square algorithm: 3  $H(m+1) = H(m) + \mu T \{conj(E(m)) \cdot C(m+1)\};$ 4 5 H(m) is coefficients at a symbol time m; H(m+1) is coefficients at a symbol time (m+1); 6 7 ì is a predetermined gain; 8 T() is the Toeplitz Matrix; E(m) is the vector of error values; and 9 C(m+1) is the decoded symbol at the symbol time (m+1). 10

The decision feedback equalizer as claimed in

Toeplitz

Matrix

the

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 $h_{(i)}...h_{(2k+1)}$  are equal to 0.

$$\begin{cases} h_{(k+i)} & h_{(k+2)} & \cdots & \cdots & h_{(2k+i)} \\ h_k & h_{(k+1)} & \cdots & \cdots & h_{2k} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ h_2 & h_3 & \cdots & \cdots & h_{(k+2)} \\ h_1 & h_2 & \cdots & \cdots & h_{(k+1)} \\ \end{cases} \\ = is \begin{cases} E^*(n-k)\cdot C(n-k) & E^*(n-k)\cdot C(n-(k-1)) & \cdots & \cdots & E^*(n-k)\cdot C(n) \\ E^*(n-(k-1))\cdot C(n-k) & E^*(n-(k-1))\cdot C(n-(k-1)) & \cdots & \cdots & E^*(n-(k-1))\cdot C(n) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ E^*(n-1)\cdot C(n-k) & E^*(n)\cdot C(n-(k-1)) & \cdots & \cdots & E^*(n-1)\cdot C(n) \\ E^*(n)\cdot C(n-k) & E^*(n)\cdot C(n-(k-1)) & \cdots & \cdots & E^*(n-1)\cdot C(n) \\ \end{cases} \\ = the channel is steady, the values of the elements in the diagonal lines of the Toeplitz Matrix are almost the same, 
$$h_{11} = h_{22} = \ldots = h_{(k+1)}(k+1), \qquad h_{21} = h_{32} = \ldots = h_{(k+1)k}, \ldots \qquad , h_{k1} = h_{(k+1)2}, \\ h_{12} = h_{23} = \ldots = h_{k(k+1)}, \quad h_{13} = h_{24} = \ldots = h_{kk}, \ldots, \quad h_{1k} = h_{2(k+1)}. \end{cases} \\ = 10. The decision feedback equalizer as claimed in claim 27, wherein, in the Toeplitz Matrix 
$$\begin{bmatrix} h_{(k+1)} & h_{(k+2)} & \cdots & \cdots & h_{(2k+1)} \\ h_k & h_{(k+1)} & \cdots & \cdots & h_{2k} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ h_2 & h_3 & \cdots & \cdots & h_{(k+2)} \\ h_1 & h_2 & \cdots & \cdots & h_{(k+1)} \end{bmatrix}, for any (2k+1) \geq i > (k+1), the$$$$$$